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ORNL

FOREIGN TRIP REPORT

TA 420879

DATE: May 10, 2017

SUBJECT: Report of Foreign Travel to Geel, Belgium – Klaus H. Guber, Reactor and Nuclear Systems Division

TO: Angela Chambers, Nuclear Criticality Safety Program Manager, National Nuclear Security Administration / NA-511/GTN, 1000 Independence Ave., SW, Washington, DC 20585-1290

FROM: Klaus H. Guber

**MEETING:
TITLE** N/A

**MEETING:
LOCATION** JRC-Geel, Geel, Belgium

**MEETING:
DATES** 4/4/2018 – 4/27/2018

**ATTENDEES:
ON BEHALF
OF NCSP** Klaus H. Guber

**MEETING:
BENEFIT TO
NCSP** Dr. Guber is a nuclear data specialist who has experience in nuclear data measurements, and he traveled to Geel, Belgium to perform neutron cross-section measurements using the Geel Electron Linear Accelerator (GELINA) at JRC-Geel. The measurements have been performed in accordance with the Nuclear Criticality Safety Program (NCSP) Five Year Plan, and the measurements provide needed nuclear data for the NCSP.

PURPOSE: The main purpose of the travel is to perform nuclear cross-section measurements at the Joint Research Center of the European Union (JRC-Geel) in Geel, Belgium. The primary objective during this trip was to continue neutron capture cross-section measurements on for La samples at JRC-Geel. Furthermore, additional work includes data reduction and sorting tasks for previous measurement campaigns for the La sample transmission data at JRC-Geel. All of these work tasks have been performed for the NCSP, and the nuclear data measurement work is performed in collaboration with JRC-Geel of the European Community.

**SITES:
VISITED** The Joint Research Institute of the European Community, Geel, Belgium

ABSTRACT: The traveler visited JRC-Geel in Geel, Belgium. At JRC-Geel, the objective of the visit is to continue additional neutron capture cross-section measurements for La using samples of various thickness at the GELINA facility. During the visit, Guber performed data reduction tasks for La transmission data obtained through measurements with a thin and thick sample.

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REPORT OF FOREIGN TRAVEL

**Klaus Guber
Geel, Belgium
April 4 – April 27, 2018**

PURPOSE OF TRAVEL

The main purpose of the travel is to perform nuclear cross-section measurements at JRC-Geel in Geel, Belgium. The primary objective of this trip was to continue transmission and neutron capture cross-section measurements on lanthanum samples of various thickness at JRC-Geel. Also, data sorting and reduction for the newly La sample was started (see previous report). These work tasks have been performed for the NCSP, and the nuclear data measurement work is performed in collaboration with JRC-Geel of the European Community.

Report

Klaus Guber traveled to JRC-Geel to perform nuclear data measurement and analysis work for the NCSP. At JRC-Geel, the GELINA (Geel Electron Linear Accelerator) neutron facility can be used to perform neutron-induced cross-section measurements in the neutron energy range from thermal up to ~20 MeV that includes the resonance region for many isotopes/nuclides of interest to the NCSP. GELINA is similar in capability to the Oak Ridge Electron Linear Accelerator (ORELA) in the U.S.; however, ORELA is no longer available for performing neutron cross-section measurements. GELINA is a neutron source driven by a pulsed electron beam, which produces neutrons via Bremsstrahlung from a uranium target. Due to a special compression system, the accelerated electron pulse of GELINA can be compressed to one nsec pulse width at full power. In combination with a long flight path, the GELINA facility provides excellent time-of-flight (TOF) resolution, which determines the neutron energy. Therefore, individual resonances of the cross section can be resolved at much higher neutron energies, and this neutron energy-resolution capability is essential for determining the detailed neutron cross-section structure for nuclides of importance to criticality safety applications.

In the course of this trip, the La neutron cross-section measurements were continued. This included finalizing the obtained transmission data for the total cross section measurements. Measurement for sample in and sample out were performed with different background filters. These filters are “black” for neutrons of a particular energy and scatter all neutrons out of the beam. Having black filters at different neutron energies give several points to fit the background for the sample in and sample out measurements. Additionally, neutron capture experiments for the thin La sample were started and once finalized will be continued with the thick La sample. Background correction of the neutron capture for La and the reference sample had been started during the last trip.

Beside the experiments, another focus on this trip was to start the data sorting tasks at JRC-Geel for the previous neutron transmission experiment measurements using La samples. For this task, the GELINA specific software packages AGL and AGS were used. In the first step, all runs were checked for consistency using the recorded scalers. In a second step the accepted list mode data runs were sorted into TOF spectra. This data conversion was completed for the sample in and sample out as well as various runs with black resonance filters. With AGS, the data can be converted to cross-section data or transmission data, respectively. The GELINA data-reduction software enables the experimentalist to process all experimental

uncertainties in a consistent way to produce a covariance matrix describing all experimental effects, and the experimental covariance data are essential for supporting the cross-section covariance evaluation effort.

Additionally, the previously sorted data for the Fe calibration sample for the Ce runs was revisited to find the error happened during the last visit.

Based on preliminary analysis of the La data, the measured cross-section data are useful to support subsequent resonance evaluation work at ORNL as planned in the NCSP Five Year Plan. GELINA's high neutron flux in combination with a short pulse width and long flight path might enable ORNL to extend the resolved resonance region for La beyond the existing resonance evaluation limit. In the high-energy neutron region, the dominating factor determining neutron energy resolution is the neutron pulse width.

The traveler had discussions with P. Dessange from Strassbourg University about neutron induced U238 inelastic cross section experiments performed at GELINA using the conversion electrons detection technique. This technique might be the only way to obtain direct information about the first inelastic level in U238 because these low energy gamma rays will not leave the sample.

Overall, Guber's foreign travel to JRC-Geel was essential to enable ORNL to complete the planned NCSP measurement and evaluation tasks as defined in the NCSP Five Year Plan.

Persons Contacted at JRC-Geel

Peter Schillebeeckx, Host
Arjan Plompen, Section Head NP Unit
Peter Siegler
Stefan Kopecky
Jan Heyse
Philippe Dessange

Itinerary and Schedule

04/04/18 – 04/05/18	Travel from Knoxville to Geel, Belgium
04/05/18	JRC-Geel -GELINA, Geel, Belgium. Preparing data from previous La runs for sorting into TOF spectra.
04/06/18	JRC-Geel -GELINA, Geel, Belgium. Data sorting
04/07/18 – 04/08/18	Weekend
04/09/18	out sick with food poisoning
04/10/18	JRC-Geel -GELINA, Geel, Belgium. Discussion about the accelerator schedule and beam diagnostics. Calibration of experimental set up. Start of experiments for La neutron capture. Prepare for La(n, γ) experiments using thin sample, start of experiments.
04/11/18	JRC-Geel -GELINA, Geel, Belgium. Sorting data, La(n, γ) experiments. Discussion with P. Dessange about $^{238}\text{U}(n,n'\gamma)$ experiments, sorting data
04/12/18	JRC-Geel -GELINA, Geel, Belgium. Sorting data, La(n, γ) experiments.
04/13/18	JRC-Geel -GELINA, Geel, Belgium. Sorting data, La(n, γ) experiments.
04/14/18 – 04/15/18	Weekend

04/16/18	JRC-Geel -GELINA, Geel, Belgium. Calibration of experimental set up. Problems with GELINA. Data sorting. Check of earlier Fe calibration run which showed problems
04/17/18	JRC-Geel -GELINA, Geel, Belgium. Problems with GELINA. New data sorting of earlier Fe calibration run which showed problems.
04/18/18	JRC-Geel -GELINA, Geel, Belgium. Problems with GELINA. New data sorting of earlier Fe calibration run which showed problems. Data sorting.
04/19/18	JRC-Geel -GELINA, Geel, Belgium. Start of GELINA. Calibration of experimental set up. Start of experiments for La neutron capture. Finalize sorting Fe runs. Data sorting.
04/20/18	JRC-Geel -GELINA, Geel, Belgium. Sorting data, La(n, γ) experiments.
04/21/18 – 04/22/18	Weekend
04/23/18	JRC-Geel -GELINA, Geel, Belgium. Calibration of experimental set up. Continue La(n, γ) experiments. Sorting of La transmission list mode for data into TOF spectra.
04/24/18	JRC-Geel -GELINA, Geel, Belgium. Continue La(n, γ) experiments. Sorting of La transmission list mode for data into TOF spectra.
04/25/18	JRC-Geel -GELINA, Geel, Belgium. Continue La(n, γ) experiments. Sorting of La transmission list mode for data into TOF spectra.
04/26/18	JRC-Geel -GELINA, Geel, Belgium. Continue La(n, γ) experiments. Sorting of La transmission list mode for data into TOF spectra. Finalizing sorted data and save data to external disk for transfer to ORNL.
04/27/18	Travel from Geel, Belgium to Knoxville, USA

DISTRIBUTION

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